

1.3.2 dB.- The term **dB**, as used herein, shall refer to decibels defined as ten times the logarithm of the power ratio ($dB = 10 \log P_2/P_1$).

1.3.3 Omnidirectional antenna.- The term omnidirectional antenna, as used herein, shall describe a radiating element or combination of radiating elements that produces a uniform radiation pattern in the horizontal plane.

- **1.3.4 Yagi type.**- The term **Yagi** type, as used herein, shall denote a class of antennas comprising an exciter dipole with reflector, and one or more coplanar director elements.

1.3.5 Antenna gain.- The term antenna gain, as used herein, shall denote the-radiated antenna power' relative to that of a half-wavelength dipole measured along the forward direction. Note the antenna gain relative to an isotropic point source is equal to **2.15** plus the antenna gain (relative to a half-wavelength dipole).

1.3.6 E plane radiation pattern.- The term E plane radiation pattern, as used herein, is the antenna radiation pattern measured in the plane of the radiator element(s).

1.3.7 Radome.- The term **radome**, as used herein, shall denote a weatherproof enclosure formed of fiberglass used for the environmental protection of antennas.

1.3.8 Mean time between failures (MTBF).- The term mean time between failures, as used herein, shall denote the statistical mean time measured in hours that the equipment operates according to specification between failures.

1.3.9 Mean time to replace (MTTR).- The term mean time to replace, as used herein, shall denote the statistical mean time measured in minutes to replace a defective antenna. Travel time is excluded in **MTTR**.

1.3.10 Antenna failure.- The term antenna failure, as used herein, shall denote the operational status of the antenna when a malfunction occurs which results in the antenna being unable to meet performance requirements as set forth in the specification.

2. APPLICABLE DOCUMENTS.- The following documents of the exact issue shown form a part of this specification to the extent specified herein.

2.1 FAA Specifications

FAA-G-2100e Electronic Equipment, General Requirements, June 22, 1981

FAA-STD-013a Quality Control Program Requirements

2.2 Military documents

MIL-STD-454J Standard, General Requirements for Electronic Equipment, Requirement 9

MIL-C-45662a Calibration System Requirements

2.3 Other documents

NTIA Manual Manual of Regulations and Procedures for Federal Radio Frequency Management, National Telecommunications and Information Administration (NTIA) Manual, May 1986 edition, including May 1987 revisions

(Copies of this specification and other applicable FAA specifications and standards may be obtained from the Contracting Officer in the Federal Aviation Administration office' issuing the invitation for bids or requests for proposals. Requests should fully identify materials desired; i.e., specification and amendment numbers and dates. Requests should cite the invitation for bids, request for proposals, or the contract involved, or other use to be made of the requested material.)

(Information on obtaining copies of the NTIA manual may be obtained from NTIA, 14th and Constitution Avenue, N.W., Washington, D.C. 20230, Attn: Publication Officer.)

(Single copies of military standards and specifications may be requested by mail or telephone from the U.S. Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania, 19120. For telephone requests, call 215-697-3321, 8 AM to 4:30 PM Monday through Friday. No more than five items may be ordered on the same request. The applicable invitation for bids or contract number should be cited.)

3. REQUIREMENTS

3.1 General.- The equipment furnished under this specification shall meet the requirements of the National Telecommunications and Information Administration (NTIA) "Manual of Regulations and Procedures for Federal Radio Frequency Management," for antennas.

The antennas defined in this specification will be operated in a single frequency environment in the frequency range of 406.1 to 420 MHz with one radio station operating as the master station and the other stations operating as slaves. The antenna for the master station shall be Type A, omnidirectional, and provide radiative connectivity with all slave stations. The antenna for the slave stations shall be Type B or Type C, directional, and provide radiative connectivity with the master station.

Approval of the quoted antennas by the Contracting Officer is required prior to shipment.

3.2 Equipment to be furnished by the contractor.- The contractor shall furnish the following in quantities to be specified in the contract:

Type A Antenna: Omnidirectional antenna (3.2.1), with mounting hardware (3.2.3)

Type B Antenna: Directional antenna of Yagi type (3.2.2), with mounting hardware (3.2.3)

Type C Antenna: Directional 'antenna of **Yagi** type (3.2.2), with **radome** enclosure (3.2.2.9) and mounting hardware (3.2.3)

3.2.1 Type A omnidirectional antenna.- The omnidirectional antenna shall meet the requirements as specified in 3.2.1.1 through 3.2.1.9.

3.2.1.1 Frequency range.- The antenna shall meet all requirements over the frequency range of 406.1 to 420 MHz.

3.2.1.2 Impedance.- The antenna shall have a nominal impedance of 50 ohms.

3.2.1.3 Voltage-standing-wave-ratio.- The voltage-standing-wave-ratio (VSWR) shall not exceed 1.5:1 over the specified frequency range.

3.2.1.4 Polarization.- The antenna shall be vertically polarized.

3.2.1.5 Radiation pattern.- The radiation beamwidth in the vertical (E) plane shall not exceed 30 degrees at the half-power points.

3.2.1.6 Gain.- The antenna shall have a gain of 3 dB minimum.

3.2.1.7 Power input.- The antenna shall operate with power input levels up to 100 watts.

3.2.1.8 Termination.- The antenna shall terminate in a bulkhead Type N female connector.

3.2.1.9 Lightning protection.- The lightning protection for the antenna assembly shall be by way of direct ground through the mounting hardware.

3.2.2 Type B,C directional antenna.- Type B directional antenna -shall meet the requirements as specified in 3.2.2.1 through 3.2.2.8. Type C directional antenna shall meet the requirements as specified in 3.2.2.1 through 3.2.2.9.

3.2.2.1 Frequency range.- The antenna shall meet all requirements over the range of 406.1 to 420 MHz.

3.2.2.2 Impedance.- The antenna shall have a nominal impedance of 50 ohms.

3.2.2.3 Voltage-standing-wave-ratio.- The voltage-standing-wave-ratio (VSWR) shall not exceed 1.5:1 over the defined- frequency range.

3.2.2.4 Polarization.- The antenna mounting shall allow either horizontal or vertical polarization.

3.2.2.5 Gain.- The antenna shall have a gain of 10 dB minimum.

3.2.2.6 Power input.- The antenna shall operate with power input levels up to 100 watts.

3.2.2.7 Termination.- The antenna shall terminate in a bulkhead Type N female connector.

3.2.2.8 Lightning protection.- The lightning protection for the antenna assembly shall be by way of direct ground through the mounting hardware.

3.2.2.9 Radome enclosure.- Type C antenna shall include a **radome** enclosure of fiberglass construction.

3.2.3 Mounting hardware.- The mounting hardware shall be of stainless steel construction and include either dual V-shaped bolts or alternate V-shaped hardware for clamping the antenna to a vertical support pipe of diameter between 1 1/4 and 2 3/4 inches. The mounting hardware for Type A antenna shall allow clamping the antenna to both a concentric and offset vertical cylindrical **pipe**. The mounting hardware for Type **B,C** antenna shall provide the capability of mounting the antenna (including the **radome** when so specified) for horizontal or vertical polarization.

3.3 Environmental requirements.- The antennas and mounting hardware shall meet operating and functional requirements specified in 3.2.1 and 3.2.2 when operating under the following environmental conditions described in FAA-G-2100, Table III, Environment III.

Temperature	-50°C to +70C
Relative humidity	5 percent to 100 percent
Altitude above sea level	0 to 10,000 feet
Wind	100 mph, Type B antenna
Wind (1/2 inch ice loading)	100 mph, Type A,C antenna

3.3.1 Survival requirements.- The antennas and mounting hardware shall meet operating and functional requirements specified in 3.2 after being subjected to the following environmental conditions. The mounting hardware shall be capable of maintaining the antenna in a-fixed physical orientation when subjected to the following environmental conditions.

Wind	125 mph, Type B antenna
Wind (1/2 inch ice loading)	125 mph, Type A,C antenna

3.4 Storage condition requirements.- The antenna shall meet functional requirements subsequent to storage under the following conditions.

Temperature	-50°C to +70°C
Relative humidity	5 percent to 95 percent non-condensing
Altitude	0 to 40,000 feet

3.5 Mechanical requirements

3.5.1 Construction

3.5.1.1 Antenna construction.- The antenna shall have a construction that ensures the environmental requirements specified in 3.3 and survival requirements specified in 3.3.1 are met. Type A omnidirectional antenna may be provided with a fiberglass outer sleeve if necessary to-meet the environmental and survival requirements.. The antenna and mounting hardware shall be constructed of materials that resist corrosion. Mounting hardware made of stainless steel shall have corrosion protection in accordance with **FAA-G-2100, 3.6.4.2**. Use of dissimilar adjoining metals which could cause corrosion at the metal junctions shall be avoided.

3.2.2.8 Lightning protection.- The lightning protection for the antenna assembly shall be by way of direct ground through the mounting hardware.

3.2.2.9 Radome enclosure.- Type C antenna shall include a **radome** enclosure of fiberglass construction.

3.2.3 Mounting hardware.- The mounting hardware shall be of stainless steel construction and include either dual V-shaped bolts or alternate V-shaped hardware for clamping the antenna to a vertical support pipe of diameter between 1 1/4 and 2 3/4 inches. The mounting hardware for Type A antenna shall allow clamping the antenna to both a concentric and offset vertical cylindrical **pipe**. The mounting hardware for Type **B,C** antenna shall provide the capability of mounting the antenna (including the **radome** when so specified) for horizontal or vertical polarization.

3.3 Environmental requirements.- The antennas and mounting hardware shall meet operating and functional requirements specified in 3.2.1 and 3.2.2 when operating under the following environmental conditions described in FAA-G-2100, Table III, Environment III.

Temperature	-50°C to +70C
Relative humidity	5 percent to 100 percent
Altitude above sea level	0 to 10,000 feet
Wind	100 mph, Type B antenna
Wind (1/2 inch ice loading)	100 mph, Type A,C antenna

3.3.1 Survival requirements.- The antennas and mounting hardware shall meet operating and functional requirements specified in 3.2 after being subjected to the following environmental conditions. The mounting hardware shall be capable of maintaining the antenna in a-fixed physical orientation when subjected to the following environmental conditions.

Wind	125 mph, Type B antenna
Wind (1/2 inch ice loading)	125 mph, Type A,C antenna

3.4 Storage condition requirements.- The antenna shall meet functional requirements subsequent to storage under the following conditions.

Temperature	-50°C to +70°C
Relative humidity	5 percent to 95 percent non-condensing
Altitude	0 to 40,000 feet

3.5 Mechanical requirements

3.5.1 Construction

3.5.1.1 Antenna construction.- The antenna shall have a construction that ensures the environmental requirements specified in 3.3 and survival requirements specified in 3.3.1 are met. Type A omnidirectional antenna may be provided with a fiberglass outer sleeve if necessary to-meet the environmental and survival requirements.. The antenna and mounting hardware shall be constructed of materials that resist corrosion. Mounting hardware made of stainless steel shall have corrosion protection in accordance with **FAA-G-2100, 3.6.4.2**. Use of dissimilar adjoining metals which could cause corrosion at the metal junctions shall be avoided.

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality control.- The contractor shall provide and maintain a quality control program in accordance with **FAA-STD-013a**. All tests and inspections made under this program shall be subject to review by the Government.

4.2 Tests

4.2.1 Test procedures.- The contractor shall submit to the Government for approval test procedures which will demonstrate the compliance of equipment performance- with- the specifications. The test procedures shall address each paragraph and/or subparagraph of the specification that is indicated in Table I as requiring production acceptance tests and evaluation. Acceptance tests and evaluation shall consist of one or more of the following: analysis, demonstration, and inspection.

4.2.1.1 Production tests and inspections.- The contractor shall perform standard production tests as well as all tests identified in Table I. The government may witness the performance of these tests.

4.2.1.2 Demonstration and analysis.- Demonstrations and analyses that are required per Table I to establish compliance with specifications shall be conducted on the basis of one demonstration (analysis) per each antenna type.

4.2.2 Test results.- The contractor shall submit test results (which shall include analyses, if so specified by the Contracting Officer, for those paragraphs and/or subparagraphs listed in Table I as requiring analysis) to the Government for review and approval prior to final acceptance.

4.2.3 Test equipment.- The contractor shall supply all test equipment necessary for tests required in this specification. Test equipment shall be maintained in accordance with **MIL-C-45662**.

4.3 Inspection of production status.- Upon request from the Government, the contractor shall make available for review at the production facility within a period of three working days, all information regarding the production status of equipment being manufactured under the contract.

5. PREPARATION FOR DELIVERY

5.1 General requirements.- Equipment, accessories and required documentation shall be packaged for shipment in a manner that prevents damage when shipped by common carrier. As a minimum, packaged equipment shall not be adversely affected by a free-fall impact on concrete from a height of **36** inches. Unpacking instructions, when required, shall be affixed to the exterior of the shipping container in a protective envelope, and shall be clearly labeled.

5.2 Marking.- The shipping container shall be clearly marked with permanent ink to provide the following information:

- (a) Antenna type (imprint one of the following as appropriate):
 - Type A Omnidirectional Antenna, Model No.
 - Type B Directional **Yagi** Antenna, Model No.
 - Type C Directional **Yagi** Antenna with **Radome**, Model No.
- (b) Name and address of manufacturer
- (c) FAA contract number under which equipment is being supplied
- (d) National-stock. number

6. NOTES.- The contents of this section are not contractually binding. Any information contained herein is for the purpose of providing background information and/or special instructions to the Contracting Officer.

6.1 Reliability.- The contractor shall, at the time of submission of bids, substantiate that the equipment will satisfy the requirements for **MTBF** and **MTTR** specified in **3.7.1 (a)** and **3.7.2 (b)** respectively. The contractor shall provide reliability testing results and/or information derived from the contractor's data base.

* * * * *

5.2 Marking.- The shipping container shall be clearly marked with permanent ink to provide the following information:

- (a) Antenna type (imprint one of the following as appropriate):
 - Type A Omnidirectional Antenna, Model No.
 - Type B Directional **Yagi** Antenna, Model No.
 - Type C Directional **Yagi** Antenna with **Radome**, Model No.
- (b) Name and address of manufacturer
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Table I. VERIFICATION REQUIREMENTS TRACEABILITY MATRIX FOR FACTORY
ACCEPTANCE TESTING OF EQUIPMENT SPECIFIED BY **FAA-E-2824** (CONT'D)

PARAGRAPH NUMBER	PARAGRAPH TITLE	TEST LEVEL	
		UNIT	REMARKS
3.4	Storage condition requirements	A,D	-
a	Temperature	Q	-
b	Relative humidity	Q	-
c	Altitude		
3.5	Mechanical requirements	-	Title
3.5.1	Construction	-	Title
3.5.1.1	Antenna 'construction .	I	
3.5.1.2	Radome construction	I	-
3.5.2	Weight	T	SS
3.6	Workmanship and finishes	I	-
3.6.1	Workmanship	I	
3.6.2	Finish	A	-
3.6.3	Nameplates	I	-
3.7	Reliability/maintainability	-	Title
3.7.1	Figures of merit	A	
a	MTBF	A	-
b	MTTR	D	
c	Preventive maintenance	D	
d	Replaceability	D	
3.8	Other requirements	-	Title
3.8.1	Documentation	D	-
3.8.2	Personnel safety	I	-
4	Quality assurance provisions	-	Title
4.1	Quality control	D	
4.2	Tests	-	Title
4.2.1	Test procedures	D	-
4.2.1.1	Production tests and inspections	I	
4.2.1.2	Demonstration and analysis	D	-
4.2.2	Test results	D	-
4.2.3	Test equipment	D	-
4.3	Inspection of production status	I	-
5	Preparation for delivery	-	Title
5.1	General requirements	T	
5.2	Marking	I	SS

Legend:

T-Test, D = Demonstration, I = Inspection, A- Analysis, **SS** = Select Sample as in **FAA-G-2100** paragraph 4.3.3.1.1, **TT** = Type Testing, V = Verification, Q = Qualification Test - to be performed on one unit to establish capability. Need not be repeated unless there is a design or supplier change, and then only to affected parts, - = Not Applicable,.



U.S. Department
of Transportation
**Federal Aviation
Administration**

FAA-E-2824
May 31, 1988

U.S. Department of Transportation Federal Aviation Administration Specification

ANTENNA, UHF

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification contains the requirements of the Federal Aviation Administration (FAA) for UHF antennas. These antennas will be used in an RF data link network of identical transceivers stationed within a maximum range of ten miles. Equipment to be delivered is required to meet the technical standards of the National Telecommunications and Information Administration (NTIA) "Manual of Regulations and Procedures for Federal Radio Frequency Management," for antennas.

1.2 Classification. Three types of UHF antenna for operation in the 406.1-420 MHz band are covered by this specification:

Type A Antenna	Omnidirectional antenna formed of a single vertical mechanical assembly, with specified mounting hardware
Type B Antenna	Directional antenna formed of a Yagi type, with specified mounting hardware
Type C Antenna	Type B antenna with radome enclosure

1.3 Definitions

1.3.1 Transceivers.- The term transceiver, as used herein, shall denote an RF component that includes both a UHF transmitter and receiver.